www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(7): 692-697

www.thepharmajournal.com
Received: 08-04-2022
Accepted: 13-06-2022

Soni Singh
Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Saurabh Dixit
Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Tarkeshwar
Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Kuldeep Yadav
Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Akriti Dutt
Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India

Corresponding Author:
Soni Singh
Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Direct and indirect effect computed between different phenotypic and genotypic level of yield relatable traits in rice (*Oryza sativa* L.) under sodic soil

Soni Singh, Saurabh Dixit, Tarkeshwar, Kuldeep Yadav and Akriti Dutt

DOI: https://doi.org/10.22271/tpi.2022.v11.i7i.13732

Abstract
The present investigation consisting a set in a fashion of line x tester cross combinations were carried out to investigate the inter characters relationship for fifteen characters in In Rice (*Oryza staiva* L.). The experiments were conducted during *Kharif*, 2019-2020 at Students Instructional Farm of Department of Genetics & Plant Breeding, Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Ayodhya-224229 (U.P.) days to 50% flowering, day to maturity, plant hright (cm), productive tillers per plant, chlorophyll content, panicle length, flag leaf area (cm), number of spikelets per panicle, spikelets fertility, grains size (L:B ratio), 1000-grain weight (g), biological yield per plant (g), harvest-index (%), protein content and grain yield per plant (g), were studied in the LxT experiment. In this study, grain yield per plant exhibited highly significant and positive association at phenotypic level with harvest index, followed by panicle length and other traits at genotypic and phenotypic correlation analysis. Character harvest index has highest direct effect on seed yield followed by biological yield per plant and some other traits at both genotypic and phenotypic path analysis. Resultant direct selection for these traits would be effective for further yield improvement in given genotype of rice.

Keywords: Rice, quantitative characters, correlation coefficient, path coefficient, genotype and phenotype

Introduction

Rice grown in India belongs to the indica sub-species. The varieties predominant in Korea, Japan and Northern China belong to Japonica where as Javanica are cultivated mainly in Indonesia. In India area, production and productivity of rice is about 45.01 million hectares during 2021-2022 with production of 122.27 million tonnes and productivity 27.11 qnt/hac. (Statista 2022) Rice constitutes a significant portion of the daily diet particularly in developing countries of Asia, supplying 50-80% of the daily caloric intake, proteins, minerals and vitamins etc. The annual global rice production of 513.02 million tonnes was produced area of 158 million hectares in 2021-2022. Rice Production last year was 508.84 million tons. This year's 513.02 estimated millions tons could represent an increase of 4.18 million tons or 0.82% in rice production around the globe. (USDA). The population growth in most of the Asian countries, except China, continues to be around 2% per year. Hence it is very pertinent to critically consider whether the rice production can be further increased to keep pace with population growth. To meet the demand of rapidly increasing population of our country, at the current rate of population growth of 1.58% in India, the requirement of rice by 2025 is estimated to be around 140.7 million tonnes which can be achieved by increasing rice production by over 2.0 million tonnes per year in the coming decades. There is need for a paradigm shift in rice research to meet the challenges of the future decades for ensuring food security. The success of any crop breeding depends on the magnitude of genetic variability and the extent to which the desirable genes are heritable nature and amount of variability existing in the germplasm.

Heritability along with genetic advance would be more useful tool in predicting the resultant effect from selection of the best genotypes for yield and some of its components in rice. A critical survey of the genetic variability, correct understanding of the gene effects and knowledge on the extent of heritability of these traits would help in planning an effective breeding programme. It will facilitate the identification of proper genotypes for a particular agro-climate. Heterosis refers to the manifestation of superiority of F_1 performance over its parent in respect to yield, growth rate, vigour etc.

The exploitation of heterosis is primarily depending on the screening and selection of available germplasm that could be produced better combination of important agronomic characters. In the modern era hybridization is the most common method applied in crop improvement and large numbers of varieties have been developed in various crops by hybridization. The understanding of genetic architecture and direct and indirect selection parameters of agronomically important traits helps in deciding the type of variety to be developed and the breeding methodology to be followed in a particular growing situation. In order to develop high yield pure line rice varieties, it is essential to screen germplasm lines for gene action, combining ability and nature and magnitude of heterosis for different characters which is prerequisite for identification of potential rice varieties for the adverse soil conditions (salt affected soil). Although, the information on above aspects in rice is available, but most of these studies are based on irrigated and normal soil conditions and literature based on salinity conditions are meagre. Therefore, further studies aimed at generating and comparing information on above aspects in rice, are warranted to facilitate development of high yielding rice cultivars for above ecosystem.

Materials and Methods

A line x tester set of sixty-three hybrids (F_1s) was derived by crossing twenty- one diverse genotypes (Females) with 3 testers of diverse genetic background (male) *viz.,* Pusa Sugndha-5, Sarjoo 52 and Narendra 359. The twenty-one lines was made to make a sixty-three cross combinations during *kharif* 2020 to generate F_1. The sixty-three hybrids along with twenty-one parents, were evaluated in randomized complete block design with three replications along with three checks. The seed of each entry were sown in separate plots and seedlings were transplanted in single row of 3 m length with inter- and intra- row spacing of 20 cm and 15 cm, respectively. The observations were recorded on various quantitative characters *viz*. days to 50% flowering, day to maturity, plant hright (cm), productive tillers per plant, chlorophyll content, panicle length, flag leaf area (cm), number of spikelets per panicle, spikelets fertility, grains size (L:B ratio), 1000-grain weight (g), biological yield per plant (g), harvest-index (%), protein content and grain yield per plant (g). In this study, five plants in random way were selected in each row of each replication for study. All the characters were recorded under study were recorded on plot basis. Path coefficient was worked out as method suggested by Dewey and Lu (1959) [6].

Results and Discussion

The estimates of simple correlation coefficients at phenotypic and genotypic levels computed between fifteen characters under study are presented in Table: 1. The phenotypic correlation coefficients and genotypic correlation coefficients for 15 traits were analyzed in the F_1s of 63 cross combinations and their 21 parents. Differences in magnitude as well as in direction were observed for different traits. However, both genotypic correlation coefficient and phenotypic correlation coefficient exhibited similar signs with few exceptions. In general, both positive and negative character associations were observed among different traits. Further, it was also observed that the estimates of genotypic correlation coefficient were higher than the corresponding phenotypic correlations. The grain yield per plant exhibited highly significant and positive association at phenotypic level with harvest index (0.703), followed by panicle length (0.638), flag leaf area (0.607), number of spikelets per panicle (0.552), chlorophyll content (0.510), 1000-seed weight (0.496), spikelet fertility (0.462), protein content (0.357), grain size (0.299), day to 50% flowering (0.235), day to maturity (0.201) and plant height (0.177) in F_1s. The highly significantly and negatively associated with biological yield per plant (-0.217) in F_1s. Days to 50% flowering showed positive and highly significant correlation with day to maturity (0.344), flag leaf area (0.300), productive tillers per plant (0.293), panicle length (0.229), harvest index (0.181), number of spikelets per panicle (0.159). Days to 50% flowering showed positive correlation with plant height (0.117), spikelet fertility (0.037), 1000-seed weight (0.034), grain size (L:B ratio) (0.030) and chlorophyll content (0.021). Significant and negative correlation was recorded with biological yield per plant (-0.067) and protein content (-0.047). Day to maturity have been not found highly significant correlation. Positive correlation biological yield per plant (0.112), panicle length (0.100), plant height (0.087), harvest index (0.049) productive tillers per plant (0.041), flag leaf area (0.026) and number of spikelets per panicle (0.013). highly significant and negative correlation was recorded with grain size (L:B ratio) (-0.230). spikelet fertility (-0.187) and protein content (-0.123). while negative correlation was recorded with 1000-seed weight (-0.097) and protein content(-0.091).Plant height showed positive and highly significant correlation with productive tillers per plant (0.348), panicle length (0.362), harvest index (0.316), number of spikelet per panicle (-0.295), 1000- seed weight (0.237), chlorophyll content (0.230), spikelet fertility (0.216), flag leaf area (0.182) and grain size (L:B ratio) (0.177). Plant height negative and highly significant correlation only one recorded with biological yield per plant (-0.267).Productive tillers per plant showed positive and highly significant correlation with panicle length (0.710), flag leaf area (0.595), chlorophyll content (0.509), 1000- seed weight (0.504), harvest index (0.503), spikelet fertility (0.490), number of spikelet per panicle (0.469) and showed positive correlation with grain size (L:B ratio) (0.417), protein content (0.120) Highly negative correlation biological yield per plant(-0.319). Chlorophyll content have been found positive and highly significant correlation flag leaf area (0.637), 1000-seed weight (0.585), spikelet fertility (0.557), harvest index (0.518), grain size (L:B ratio) (0.493), panicle length (0.439), protein content (0.435), number of spikelet per panicle (0.418) Highly negative correlation was recorded with biological yield per plant (-0.319).Panicle length showed positive and highly significant correlation with 1000-seed weight (0.662), spikelet fertility (0.634), flag leaf area (0.606), number spikelets per panicle (0.571), harvest index

(0.561) and grain size (0.505). Panicle length showed highly positive correlation with protein content (0.057) while negative correlation was recorded with biological yield per plant (-0.273). Flag leaf area showed positive and highly significant correlation with 1000- seed weight (0.607), spikelet fertility (0.507), number of spikelet per panicle (0.436), harvest index (0.425), grain size (L:B ratio) (0.338) and protein content (0.131). Highly negative significant correlation was recorded with biological yield per plant (-0.149). Number of spikelets per panicle showed positive and highly significant correlation with harvest index (0.600), Spikelet fertility (0.571), 1000-seed weight (0.366), grain size (L:B ratio) (0.346), protein content (0.277). Negative and highly significant correlation was recorded with biological yield per plant (-0.404). Spikelet fertility showed positive and highly significant correlation with 1000-seed weight (0.565), grain size (L:B ratio) (0.500), harvest index (0.423), and protein content (0.269) while nigative and significant association with biological yield per plant (-0.251). Grain size (L:B ratio) showed positive and highly significant correlation with 1000- seed weight (0.521) , harvest index(0.296) and protein content (0.298) and negative correlation was recorded with biological yield per plant (-0.211). Thausand grain weight showed positive and highly significant correlation with harvest index (0.360), and protein content (0.223), and negative correlation was recorded with biological yield per plant (-0.118). Biological yield per plant have been not found positive and highly significant correlation. while nigative and significant association with harvest index (-0.835) and protein content (-0.290). Harvest index showed positive and highly significant correlation with protein content (0.401).Path coefficient analysis is a tool to partition the observed correlation coefficient into direct and indirect effects of yield components on grain yield. Path analysis provides moreclear picture of character associations for formulating efficient selection strategy. Path coefficient analysis differs from simple correlation in that it points out the causes and their relative importance, whereas, the later measures simply the mutual association ignoring the causation. The concept of path coefficient was developed by Wright S. (1921) and technique was first used for plant selection by Dewey and Lu (1959) [6]. Path analysis has emerged as a powerful and widely used technique for understanding the direct and indirect contributions of different characters to economic yield in crop plants so that the relative importance of various yield contributing characters can be assessed.The direct and indirect effects of fifteen characters on grain yield per plant estimated by path coefficient analysis using phenotypic and genotypic correlations have been depicted in Table:2. The highest genotypic positive direct effect on grain yield per plant was exerted by harvest-index (1.6884), followed by biological yield per plant (1.1763), flag leaf area (0.1489), grain size (L:B ratio) (0.0713), spikelet fertility (0.0578), protein content (0.0283), day to maturity (0.0173), in F_1s. exerted high order negative direct effects on chlorophyll content(-0.0996), panicle length (-0.0529) and productive tillers per plant (-0.0389). The direct effects of remaining characters were too low to be considered important in F_1s. In genotypic path analysis, harvest index (1.0129) exerted high order positive indirect effects on biological yield per plant (0.1319) *via* grain yield per plant (0.703), flag leaf area (0.0904), grain yield (L:B ratio) (0.0371), spikelet fertility (0.0366), chlorophyll content (0.0317), panicle length (0.0144), productive tillers per plant (0.0117), praotein content (0.0113), plant height (0.0095), number of spikelets per panicle (0.0038), day to maturity (0.0019),1000-seed weight (0.0017)and days to 50% flowering (0.0009) in F_1s. In genotypic path analysis, panicle harvest index (-1.4092) exerted high order negative indirect effects on biological yield per plant (-0.9818), *via* grain yield per plant (-0.217), chlorophyll content (-0.0634), panicle length (-0.0232), productive tillers per plant (-0.0272), flag leaf area (-0.0222), grain size (-0.0164) in F_1s The rest of the estimates of indirect effects obtained in phenotypic path analysis were negligible. The estimate of residual factors 0.0421 in F_1s obtained in this path analysis was low. The highest phenotypic positive direct effect on harvest index (1.5693) was exerted by biological yield per plant (1.0747), followed by flag leaf area (0.0747), grain size (L:B ratio) (0.0437), spikelet fertility (0.0282), protein content (0.0099), panicle lemgth (0.0085), day to 50% flowering (0.0027) in F_1s. The highest negative direct effect was exerted by plant height (-0.0390), productive tillers per plant (-0.0378) and chlorophyll content (-0.0193). The direct effects of remaining characters were too low to be considered important in F_1s. At phenotypic level path analysis, harvest index (0.7363) exerted high order positive indirect effects on biological yield per plant (0.1141) *via* grain yield per plant (0.718), flag leaf area (0.0390), grain size (L:B ratio) (0.0199), spikelet fertility (0.0159), productive tillers per plant (0.0112), plant height (0.0101), chlorophyll content (0.0047), panicle length (0.0034), protein content (0.0029),1000-seed weight (0.0012), day to 50% flowering (0.009), number of spikelets per panicle (0.0004) and day to maturity (0.0001) in F_1s. At phenotypic level path analysis, harvest index (-1.2637) exerted high order negative indirect effects on biological yield per plant *via* (-0.3179), grain yield per plant (-0.190), productive tillers per plant (-0.0194), chlorophyll content (-0.0096), 1000-seed weight (-0.0093), grain size (L:B ratio) (-0.0085), plant height (-0.0083) and spikelet fertility (-0.0070) in F_1s. The rest of the estimates of indirect effects obtained in phenotypic path analysis were negligible. The estimate of residual factors 0.0487 in F_1s; obtained in this path analysis was low.

Table 1(a): Estimate of genotypic correlation cofficent effects of 15 characters on grain yield per plant in rice under sodic soil

Characters	Days to 50% flowering	Day to Maturity	Plant height (cm)	Productive tillers per plant	Chlorophyll content	Panicle length (cm)	Flag leaf area (cm2)	Number of spikelet's per panicle	Spikelet fertility (%)	Grain size (L: B ratio)	1000-seed weight (g)	Biological yield per plant (g)	Harvest index (%)	Protein Content (%)	Grain yield per plant (g)
Days to 50% flowering	1.000	0.344**	0.117	0.293**	0.021	0.229**	0.300**	0.159*	0.037	0.030	0.034	-0.067	0.181**	-0.047	0.235**
Day to Maturity		1.000	0.087	0.041	-0.091	0.100	0.026	0.013	-0.187**	-0.230**	-0.097	0.112	0.049	-0.123*	0.201**
Plant height (cm)			1.000	0.384**	0.230**	0.362**	0.182**	0.295**	0.216**	0.177**	0.237**	-0.267**	0.316**	0.117	0.177**
Productive tillers per plant				1.000	0.509**	0.710**	0.595**	0.469**	0.490**	0.417**	0.504**	-0.306**	0.503**	0.120	0.485**
Chlorophyll content					1.000	0.439**	0.637**	0.418**	0.557**	0.493**	0.585**	-0.319**	0.518**	0.435**	0.510**
Panicle length (cm)						1.000	0.606**	0.571**	0.634**	0.507**	0.662**	-0.273**	0.561**	0.057	0.638**
Flag leaf area (cm2)							1.000	0.436**	0.507**	0.338**	0.607**	-0.149*	0.425**	0.131*	0.607**
Number of spikelet's / panicle								1.000	0.571**	0.346**	0.366**	-0.404**	0.600**	0.277**	0.552**
Spikelet fertility (%)									1.000	0.500**	0.565**	-0.251**	0.423**	0.269**	0.462**
Grain size (L: B ratio)										1.000	0.521**	-0.211**	0.296**	0.298**	0.299**
1000-seed weight (g)											1.000	-0.118	0.360**	0.223**	0.496**
Biological yield per plant (g)												1.000	-0.835**	-0.290**	-0.217**
Harvest index (%)													1.000	0.401**	0.703**
Protein Content (%)														1.000	0.357**
Grain yield per plant (g)															1.000

*, ** significant at 5% and 1% level, respectively

Table 1(b): Estimate of phenotypic correlation cofficent of 15 characters on grain yield per plant in rice under sodic soil

Characters	Days to 50% flowering	Day to Maturity	Plant height (cm)	Productive tillers per plant	Chlorophyll content	Panicle length (cm)	Flag leaf area (cm2)	Number of spikelet's per panicle	Spikelet fertility (%)	Grain size (L: B ratio)	1000-seed weight (g)	Biological yield per plant (g)	Harvest index (%)	Protein Content (%)	Grain yield per plant (g)
Days to 50% flowering	1.000	0.328**	0.112	0.263**	0.004	0.128*	0.258**	0.152*	0.038	0.036	0.030	-0.059	0.160**	-0.024	0.197**
Day to Maturity		1.000	0.093	0.038	-0.064	0.062	0.026	0.014	-0.178**	-0.194**	-0.085	0.106	0.045	-0.084	0.171**
Plant height (cm)			1.000	0.362**	0.165**	0.204**	0.155*	0.287**	0.212**	0.164**	0.208**	-0.258**	0.299**	0.089	0.160**
Productive tillers per plant				1.000	0.375**	0.398**	0.512**	0.451**	0.464**	0.373**	0.443**	-0.296**	0.469**	0.089	0.424**
Chlorophyll content					1.000	0.255**	0.496**	0.337**	0.447**	0.347**	0.453**	-0.244**	0.399**	0.260**	0.386**
Panicle length (cm)						1.000	0.355**	0.339**	0.371**	0.257**	0.356**	-0.161**	0.326**	-0.020	0.361**
Flag leaf area (cm2)							1.000	0.400**	0.468**	0.260**	0.522**	-0.146*	0.379**	0.096	0.498**
Number of spikelet's / panicle								1.000	0.562**	0.311**	0.335**	-0.393**	0.567**	0.223**	0.491**
Spikelet fertility (%)									1.000	0.456**	0.522**	-0.247**	0.401**	0.197**	0.408**
Grain size (L: B ratio)										1.000	0.439**	-0.184**	0.266**	0.232**	0.265**
1000-seed weight (g)											1.000	-0.110	0.317**	0.177**	0.406**
Biological yield per plant (g)												1.000	-0.805**	-0.209**	-0.190**
Harvest index (%)													1.000	0.298**	0.718**
Protein Content (%)														1.000	0.260**
Grain yield per plant (g)															1.000

*, ** significant at 5% and 1% level, respectively

Table 2 (a): Estimate of genotypic direct and indirect effects of 10 characters on grain yield per plant in rice under sodic soil

Characters	Days to 50% flowering	Day to Maturity	Plant height (cm)	Productive tillers per plant	Chlorophyll content	Panicle length (cm)	Flag leaf area (cm2)	Number of spikelet's per panicle	Spikelet fertility (%)	Grain size (L: B ratio)	1000-seed weight (g)	Biological yield per plant (g)	Harvest index (%)	Protein Content (%)	Grain yield per plant (g)
Days to 50% flowering	-0.0132	0.0060	-0.0042	-0.0112	-0.0021	-0.0121	0.0447	-0.0015	0.0021	0.0021	-0.0005	-0.0786	0.3049	-0.0013	0.235**
Day to Maturity	-0.0045	0.0173	-0.0031	-0.0016	0.0091	-0.0053	0.0038	-0.0001	-0.0108	-0.0164	0.0014	0.1319	0.0828	-0.0035	0.201**
Plant height (cm)	-0.0016	0.0015	-0.0357	-0.0147	-0.0229	-0.0192	0.0272	-0.0028	0.0125	0.0126	-0.0034	-0.3136	0.5337	0.0033	0.177**
Productive tillers per plant	-0.0039	0.0007	-0.0137	-0.0383	-0.0507	-0.0375	0.0886	-0.0044	0.0283	0.0298	-0.0071	-0.3596	0.8497	0.0034	0.485**
Chlorophyll content	-0.0003	-0.0016	-0.0082	-0.0195	-0.0996	-0.0232	0.0948	-0.0040	0.0322	0.0351	-0.0083	-0.3748	0.8752	0.0123	0.510**
Panicle length (cm)	-0.0030	0.0017	-0.0129	-0.0272	-0.0437	-0.0529	0.0903	-0.0054	0.0366	0.0361	-0.0094	-0.3212	0.9475	0.0016	0.638**
Flag leaf area (cm2)	-0.0040	0.0004	-0.0065	-0.0228	-0.0634	-0.0321	0.1489	-0.0041	0.0293	0.0241	-0.0086	-0.1751	0.7170	0.0037	0.607**
Number of spikelet's / panicle	-0.0021	0.0002	-0.0105	-0.0180	-0.0416	-0.0302	0.0649	-0.0095	0.0330	0.0247	-0.0052	-0.4748	1.0129	0.0078	0.552**
Spikelet fertility (%)	-0.0005	-0.0032	-0.0077	-0.0188	-0.0554	-0.0336	0.0755	-0.0054	0.0578	0.0356	-0.0080	-0.2956	0.7138	0.0076	0.462**
Grain size (L: B ratio)	-0.0004	-0.0040	-0.0063	-0.0160	-0.0491	-0.0268	0.0504	-0.0033	0.0289	0.0713	-0.0074	-0.2477	0.5006	0.0084	0.299**
1000-seed weight (g)	-0.0005	-0.0017	-0.0085	-0.0193	-0.0583	-0.0350	0.0904	-0.0035	0.0327	0.0371	-0.0142	-0.1383	0.6086	0.0063	0.496**
Biological yield per plant (g)	0.0009	0.0019	0.0095	0.0117	0.0317	0.0144	-0.0222	0.0038	-0.0145	-0.0150	0.0017	1.1763	-1.4092	-0.0082	-0.217**
Harvest index (%)	-0.0024	0.0009	-0.0113	-0.0193	-0.0516	-0.0297	0.0632	-0.0057	0.0244	0.0211	-0.0051	-0.9818	1.6884	0.0113	0.703**
Protein Content (%)	0.0006	-0.0021	-0.0042	-0.0046	-0.0433	-0.0030	0.0195	-0.0026	0.0155	0.0213	-0.0032	-0.3415	0.6767	0.0283	0.357**

Resi = 0.0421

*, ** significant at 5% and 1% level, respectively

Table 2 (b): Estimate of phenotypic direct and indirect effects of 15 characters on grain yield per plant in rice under sodic soil

Characters	Days to 50% flowering	Day to Maturity	Plant height (cm)	Productive tillers per plant	Chlorophyll content	Panicle length (cm)	Flag leaf area (cm2)	Number of spikelet's per panicle	Spikelet fertility (%)	Grain size (L: B ratio)	1000-seed weight (g)	Biological yield per plant (g)	Harvest index (%)	Protein Content (%)	Grain yield per plant (g)
Days to 50% flowering	0.0027	-0.0002	-0.0044	-0.0099	-0.0001	0.0011	0.0193	-0.0001	0.0011	0.0016	-0.0005	-0.0638	0.2504	-0.0002	0.197**
Day to Maturity	0.0009	-0.0005	-0.0036	-0.0014	0.0012	0.0005	0.0019	0.0000	-0.0050	-0.0085	0.0015	0.1141	0.0708	-0.0008	0.171**
Plant height (cm)	0.0003	0.0000	-0.0390	-0.0137	-0.0032	0.0017	0.0116	-0.0003	0.0060	0.0072	-0.0037	-0.2776	0.4699	0.0009	0.160**
Productive tillers per plant	0.0007	0.0000	-0.0141	-0.0378	-0.0072	0.0034	0.0383	-0.0004	0.0131	0.0163	-0.0079	-0.3179	0.7363	0.0009	0.424**
Chlorophyll content	0.0000	0.0000	-0.0064	-0.0142	-0.0193	0.0022	0.0371	-0.0003	0.0126	0.0151	-0.0080	-0.2618	0.6261	0.0026	0.386**
Panicle length (cm)	0.0004	0.0000	-0.0080	-0.0151	-0.0049	0.0085	0.0265	-0.0003	0.0105	0.0112	-0.0063	-0.1729	0.5115	-0.0002	0.361**
Flag leaf area (cm2)	0.0007	0.0000	-0.0061	-0.0194	-0.0096	0.0030	0.0747	-0.0004	0.0132	0.0114	-0.0093	-0.1567	0.5950	0.0010	0.498**
Number of spikelet's / panicle	0.0004	0.0000	-0.0112	-0.0171	-0.0065	0.0029	0.0299	-0.0009	0.0159	0.0136	-0.0059	-0.4229	0.8903	0.0022	0.491**
Spikelet fertility (%)	0.0001	0.0001	-0.0083	-0.0176	-0.0086	0.0032	0.0350	-0.0005	0.0282	0.0199	-0.0093	-0.2659	0.6295	0.0019	0.408**
Grain size (L: B ratio)	0.0001	0.0001	-0.0064	-0.0141	-0.0067	0.0022	0.0194	-0.0003	0.0129	0.0437	-0.0078	-0.1973	0.4168	0.0023	0.265**
1000-seed weight (g)	0.0001	0.0000	-0.0081	-0.0168	-0.0087	0.0030	0.0390	-0.0003	0.0147	0.0192	-0.0177	-0.1184	0.4982	0.0018	0.406**
Biological yield per plant (g)	-0.0002	-0.0001	0.0101	0.0112	0.0047	-0.0014	-0.0109	0.0004	-0.0070	-0.0080	0.0020	1.0747	-1.2637	-0.0021	-0.190**
Harvest index (%)	0.0004	0.0000	-0.0117	-0.0177	-0.0077	0.0028	0.0283	-0.0005	0.0113	0.0116	-0.0056	-0.8654	1.5693	0.0029	0.718**
Protein Content (%)	-0.0001	0.0000	-0.0035	-0.0034	-0.0050	-0.0002	0.0072	-0.0002	0.0055	0.0102	-0.0032	-0.2243	0.4674	0.0099	0.260**

Resi = 0.0487

*, ** significant at 5% and 1% level, respectively

Conclusion

In conclusion the rest of the estimates of direct and indirect effects obtained in phenotypic and path analysis. The genotypic correlations were generally similar in nature and higher in magnitude then the corresponding phenotypic correlations. Grain yield per plant showed highly significant and positive association with harvest index. Harvest index and biological yield significant and positive correlation with grain yield per plant. Existence of highly significant positive correlation amongst yield and important yield components suggested that selection would be high effective and efficient in improving these traits due to possibility of correlated response. The study of character association and path coefficient analysis indicated that harvest index and biological yield per plant had positive direct effect coupled with positive significant correlation with grain yield per plant and hence direct selection can be made based on this trait for improving grain yield in rice.

References

1. Acharya N, Acharya SS, Poudel A, Neupane N. Genetic Variability, Correlation and Path Analysis of Different Hill-Rice (*Oryza sativa*) Genotypes. Global Journal of Science Frontier Research: D Agriculture and Veterinary, 2019, 19(4).Online ISSN: 2249-4626 & Print ISSN: 0975-5896.
2. Ahamed A, Sharma V, Paswan SK, Singh VK, Verma OP. Correlation and Path Coefficient Analysis of Economically Important Traits in Rice (*Oryza sativa* L.) Germplasm under Sodic Soil, Res. J Agri. Sci. 2014;5(4):806-809.
3. Anonymous. Directorate of economics and statistics, dept. of agriculture and co-operation. Ministry of agriculture. Government of India, 2017-18.
4. Bhadru D, Reddy DL, Ramesha MS. Correlation and path coefficient analysis of yield and yield contributing traits in rice hybrids and their parental lines. Electronic J Plant Bree. 2011;2(1):112-116.
5. Borbora TK, Hazarika GN, Medhi AK. Correlation and path analysis for panicle characters in rice. Crop Res. 2005;30(2):215-222.
6. Dewey DR, Lu KH. Correlation and path coefficient analysis for components of crested wheat grass seed production. Agron. J. 1959;51:515-518.
7. Janardanam V, Nadarajan N, Jebaraj S. Correlation and path analysis in rice (*Oryza sativa* L.). Madras Agril. J. 2002;88(10-12):719-720.
8. Kishore NS, Ansari NA, Babu VR, Rani NS, Rao LV, Subba R. Correlation and path analysis in aromatic and non-aromatic rice genotypes. Agri. Science Digest. 2007;27(2):20
9. Koli NR, Chandra Prakash, Punia SS, Kumhar BL. Line X tester analysis for grain yield and its contributing traits in aromatic rice (*Oryza sativa* L.). Int. J Integrative Sci., Innovation and Tech. 2013;2(2):1-4.